

LIMITED CIRCULATION

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AGRICULTURAL MEMORANDUM NO. 1034

WEATHER CONDITIONS AND HIGH WINTER WHEAT YIELDS IN 1984
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SUMMARY

Weather conditions from September 1983 to August 1984 are related to the development stage of winter wheat crops. The coincidence of weather conditions favourable to high yields and crop growth stage are discussed and it is concluded that the weather sequence in 1984 was indeed conducive to high yields. The most important weather features in 1984 were a cool spring with high radiation followed by high radiation and average temperatures during grain filling. A dry winter and a late return to field capacity in autumn 1983 may also have been important. The effects of weather on farm operations may have been at least as important as the direct effects of weather on the growth of the crop.

INTRODUCTION

Winter wheat yields in 1984 were high throughout UK with many farmers reporting over 10 t/ha from individual fields and with averages of 8 t/ha quite common. This came as something of a surprise since the summer was very dry and many farmers thought that drought would reduce yields. Since the high yields were found throughout UK it is probable that weather factors were the cause.

DATA

Weather data from Leeming (N Yorkshire) were used since the initial enquiry came from N Region. Although there were regional differences, the main pattern of departures from average was similar throughout UK so that Leeming data is probably representative of much of the winter wheat area in UK. (Ag Memo 1033 gives some confirmation of this for Midlands and Western Region).

A graph was made using the Weekly Weather Notes, MORECS and T-sum maps. The Weekly Weather Notes data on the graph is the departure from average temperature (with the 1941-70 average plotted as well), the weekly mean maximum and minimum temperature, and also sunshine and rainfall both expressed as a percent of average. The MORECS soil moisture deficit for cereals growing on medium AWC soil is plotted for MORECS square 80. The T-sum maps were used to plot thermal time (accumulated T-sum) from 28 September since this was about the average sowing date for winter wheat.

ESTIMATION OF CROP GROWTH STAGE

The stage of development of the wheat plant apex was estimated from thermal time. In this, crop emergence was estimated at 120°C days after sowing and with the leaves requiring 130°C days each for full expansion. For crops sown in late September it is assumed that 13 leaves are produced in total. The apex stages of floral initiation, double ridges and terminal spikelet are produced at 25%, 50% and 70% of the final leaf number (much of this is from personal communications from P Biscoe and E J M Kirby). Confirmation that these numbers were reasonably correct in 1984 came from N Humberside and E Region (P Hagggar, personal communication). The apex stages calculated in this way are marked above the temperature part of the graph.

(Note: between double ridges and terminal spikelet all the detail of the grain bearing structures is initiated and by terminal spikelet the maximum potential number of grain sites has been fixed. Between terminal spikelet and anthesis the stem grows and tillers and spikelet numbers fall below the potential number set by terminal spikelet. About 40% of the total dry matter is produced between terminal spikelet and anthesis and another 40-50% during grain fill. A later sowing date would delay floral initiation considerably, terminal spikelet by 7-10 days and anthesis by only 4-7 days.)

THE WEATHER SEQUENCE

The numbers are also found on the diagram.

1. Seed was sown into warm soil which had been moistened by previous rain. Although the overall SMD was about 100 mm all parts had some rain in mid-September which ensured a rapid and even germination.
2. October was rather cold which may have restricted the development of some diseases.
3. The soil remained dry at depth until the second week in December when heavy rain brought the soil back to capacity fairly quickly. The return date was one or two weeks later in some parts of Eastern Region. The return to capacity date was about 7 weeks later than normal, though only 3 to 4 weeks later than normal in parts of Eastern Region. All parts had large SMD till early December and this may have allowed the roots to penetrate deeper than is usual.
4. The winter was drier than normal. The excess winter rain had about lower quartile frequency over large areas which should have caused less leaching than usual. The risks of waterlogging would also be less so that if the roots had gone deeper because of the dry autumn they would be more likely to survive.
5. Below average temperatures from double ridges to terminal spikelet. As a consequence the development of the ear was slow which seems to be beneficial in ensuring a high number of potential grain sites.
6. Another cool period between terminal spikelet and anthesis. Temperatures were particularly low in Eastern Region (about 2.0° below normal for the month of May) associated with persistent north east winds. This caused slow development and allowed more radiation to be absorbed during the stem extension phase when the stem and ear are in competition with each other.
7. Radiation totals were high for 2-3 weeks following terminal spikelet in late April and early May. This must have produced large increases in dry matter which helped to grow the stem and ear and to minimise the amount of tiller and spikelet death which always happens after terminal spikelet.
8. The grain filling phase had near average temperatures and high radiation totals. Night time temperatures were generally below average which may have been significant in reducing the plant's respiration losses. Experiments have shown that the majority of dry matter for the grain comes from photosynthesis during the grain filling phase. High radiation ensures ample photosynthesis and the near average temperatures imply that leaf death was not premature. However SMDs reached 120 mm according to MORECS for medium AWC soils by the third week in July. Eastern Region had lower deficits due to outbreaks of thundery showers. Gales and Wilson (1981) and Goss et al (1984) both conclude that since winter wheat crops are relatively deep rooting they have access to about 75% of their total water use from April to harvest on clay and silt loam soil. A reduction of dry matter production due to drought causing stomatal closure is therefore thought to be unlikely. However, significant loss of dry matter production may have occurred on light soils and in soils with restricted depth. In 1976 similar SMDs to 1984 were observed and seemed to be associated with a yield reduction of about 25%. However, the grain filling period in 1976 was much hotter than in 1984 which may partly explain the yield losses in that year.

Other factors which may have buffered against the dry spell include deeper than average rooting and the plant process of translocation of assimilate stored in the stem. The dry autumn may have caused deeper rooting, and the steady rise in SMD in April and May coupled with high sunshine may have caused extra roots to grow. The translocation of stem material laid down before anthesis to the developing ear has sometimes been shown to provide a significant fraction of the final grain yield. Gallagher et al (1976) thought that the process may have been significant in the drought year of 1976. However a more recent paper (Daniels et al (1982)) shows that translocation tends to be a property of low yield crops and that high yielding crops continue to lay down material in the stem as well as the growing ear.

MANAGEMENT FACTORS

So far only the direct effects of weather on crop growth have been considered, but timely farm operations done in favourable weather are likely to have at least the same effects on yield as the direct growth factors.

1. Subsoiling. The dry autumn weather in 1983 together with the depth of dry soil probably produced good subsoiling work while doing minimal damage to the surface soil. There were many weeks ideal for the work. Goss et al (1984) have shown how subsoiling can significantly increase the available water supply to crops due to a greater rooting depth.
2. There may have been a general move to earlier sowing. For winter wheat the yield increases with earlier sowing date at least until the third week in September (C F Green and J D Ivins, J Ag Sci (in press)).
3. There was good weather for spraying and top dressing fertiliser in April - warm, dry, light winds. Only the first week in April had widespread frost. The wet period at the end of May and early June caused some concern about Septoria, but perhaps it encouraged greater fungicide application than otherwise.
4. The harvesting weather in August was perfect. There was very little rain, light winds and warm temperatures.

CONCLUSION

The weather sequence in 1983/4 was favourable to crop growth throughout most of the period. High yields can only come from high dry matter accumulation which in turn implies high absorption of solar radiation. The most significant factors are therefore several periods of above average sunshine from late April to July accompanied by average or below average temperature. Good weather for spraying/top dressing in April and excellent harvest conditions must also have played a large part.

Meteorological Office,
Harrogate
October 1984

REFERENCES

- Daniels, R W and Alcock, M B., 1982. A re-appraisal of stem reserve contribution to grain yield in spring barley. (*Hordeum vulgare* L) J Agric Sci, Camb. 98, 347-455.
- Gales, K and Wilson, N J., 1981. Effects of water shortage on the yield of winter wheat. Annals of Applied Biology. 99, 323-334.
- Gallagher, J N, Biscoe, P V and Hunter, B., 1976. Wheat growth in drought. Nature. 264, 542. 9 Dec.
- Goss, M J., Howse, K R., Vaughan-Williams, J M., Ward, M A and Jenkins, W., 1984. Water use by winter wheat as affected by soil management. J Agric Sci, Camb. 103, 189-199.

LEE MINC

1983

1984

WEEK 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34

AIR

SOON

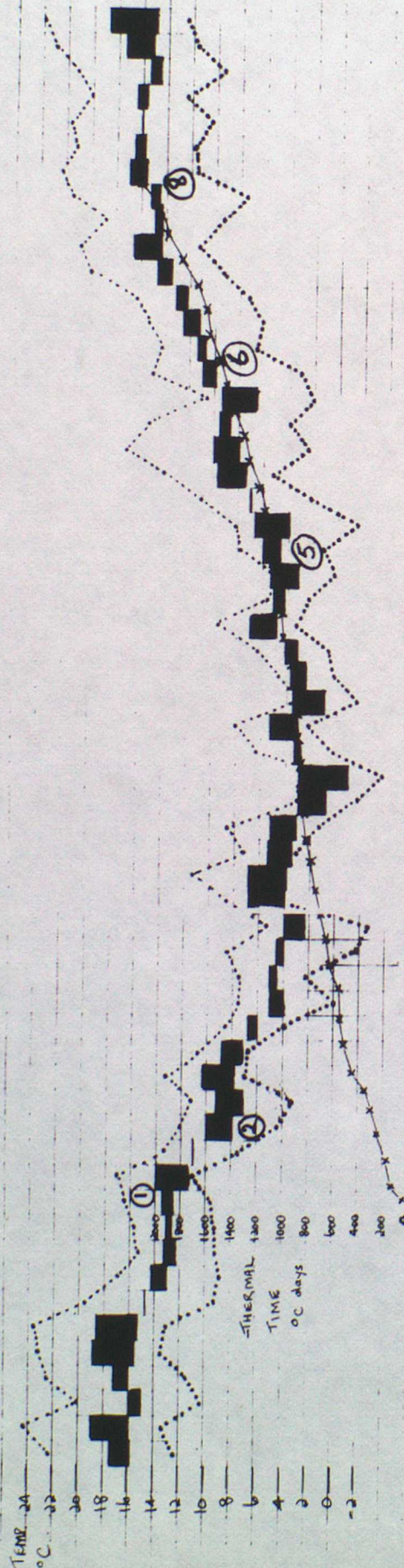
PROBABLY

DOUBLE

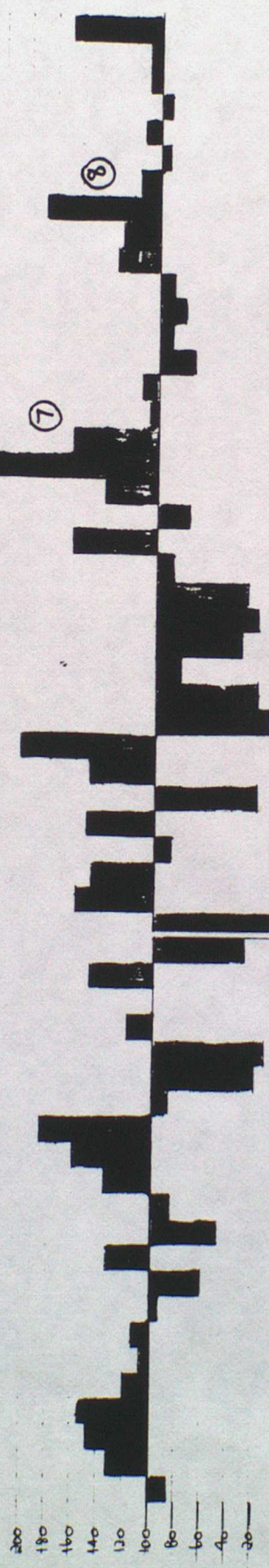
SPINULET

ARMLESS

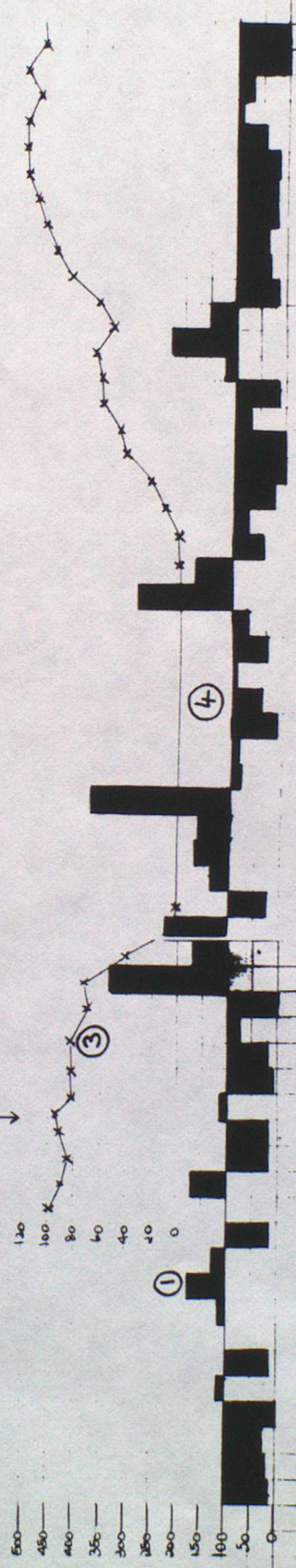
DOWN



SUN % OF AVERAGE



RAIN % OF AVERAGE



WEEK 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34

JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST